

# **A Novel Application of High-Carbon Fly-Ash as an Industrial Binder**

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## **Summary**

Carbon is usually considered a contaminant in fly-ash utilization. Recently, research has concentrated on removing carbon from fly-ash, but this is expensive, and so we are concentrating on applications where the carbon is a benefit. We have developed a new industrial high carbon fly-ash based binder (HC-FBB) that utilizes fly-ash in applications where the carbon is desirable. The carbon has the advantage of acting as a fuel and a reductant in iron ore and desulfurization slag pellets and is likely to improve permeability. In addition, finely divided carbon, routinely added to foundry sands to improve the surface quality of cast metal parts, is inherent to the HC-FBB. HC-FBB is a less-expensive alternative to existing binders (bentonite clay and organic binders), which are the typical binders used to agglomerate fine particulates into strong pellets, briquettes, foundry molds, and other useful forms. Most U.S. iron and steel is produced with iron ore pellets. Each year, iron ore pelletizing uses approximately 600 thousand tons of bentonite binder, costing about \$35 million. Over 100 million tons of bentonite is used as foundry sand bond, annually. Two-thirds of the cost is from shipping the bentonites from out west to the Lake Superior iron ore pelletizing district. Fly-ash is produced at or near these pelletizing plants. Using HC-FBB could result in a significant cost savings to domestic iron and steel producers.

Iron ore pellet plants are interested in partial or gradual replacement of bentonite with HC-FBB. The goal was to determine whether bentonite and HC-FBB are compatible. and answer the questions: "What will happen if we mix these two binders together? Will these binders complement one another to improve pellet strengths?"

Iron ore pelletization tests were conducted to determine the compatibility between bentonite and HC-FBB. Iron ore pellets made with either bentonite alone or FBB alone exceeded industrial standards, while pellets made with combinations of FBB and bentonite binders had reduced dry magnetite pellet compressive strengths below the industrially acceptable value of 22 newtons (5 lbf). Activators and accelerators that activated the fly-ash, deactivated the bentonite. Reduction in strength as HC-FBB was replaced by bentonite was most likely from soluble calcium ion addition from the calcium hydroxide activator and calcium chloride accelerator. It is expected that either the high performance sodium-montmorillonite of the bentonite binder transformed through cation exchange of Na with Ca into a lower performance, less absorbent calcium-montmorillonite, and/or that changes in concentrate moisture pH by hydroxide addition from calcium hydroxide affected the bentonite binding characteristics. The incompatibility of these two binders is discussed in detail in the presentation.

HC-FBB was also used successfully as a binder for foundry molds, iron ore pellets, and for recycling steel mill desulfurization slag. Each year, 50,000 tons of desulfurization slag is produced at just one particular steelmaking plant; each year this single plant could consume over 150 tons of fly-ash annually in pelletizing this material for recycling.

Bentonite fiber technology is also described in this paper. When bentonite fibers are formed under certain mixing conditions it becomes a much more effective binder. Using a new roll mixing technology to develop bentonite into fibers doubled iron ore pellet strengths and allowed the dosage to be cut in half. Bentonite fiber technology was applied to foundry molds and improved dry compressive strengths from 150 to 370 psi and was three times more effective at improving strength than using a typical mixer-muller. This suggests the use of similar technologies to improve HC-FBB performance.

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